6-9-2016

Predictive resource planning: coupling construction needs with demolition waste forecasts

Elisabeth Keijzer
TNO, elisabeth.keijzer@tno.nl

Jacco Jochemsen-Verstraeten
TNO

Sanne van Leeuwen
TNO

Mara Hauck
TNO

Elmer Rietveld
TNO

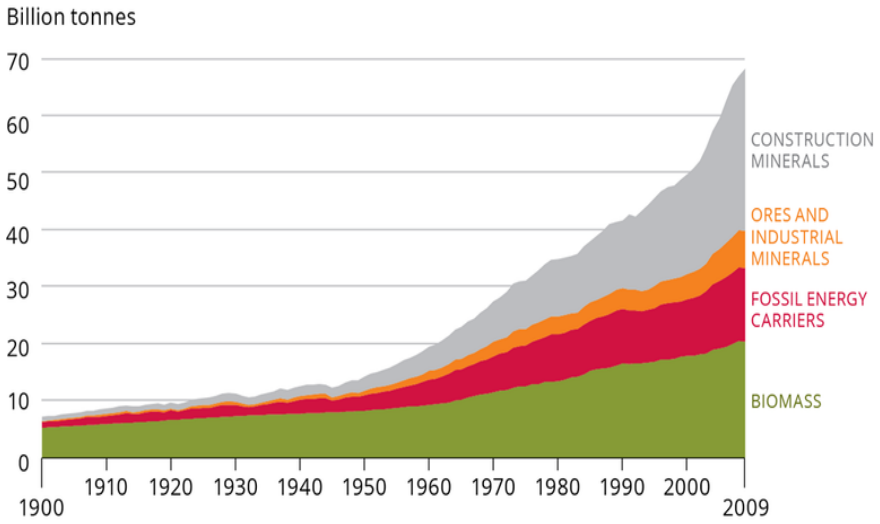
PREDICTIVE RESOURCE PLANNING:
COUPLING CONSTRUCTION NEEDS WITH DEMOLITION WASTE FORECASTS

Elisabeth Keijzer, Jacco Verstraeten-Jochemsen, Sanne van Leeuwen, Mara Hauck, Elmer Rietveld

TNO innovation for life

RESOURCE EFFICIENCY IN THE CONSTRUCTION SECTOR

- EU Waste Framework Directive: recycle/recover 70% of non-hazardous construction and demolition waste (CDW) by 2020
- Current recycling systems function insufficiently (Dahlbo et al., 2015)
- New processes & techniques *could* lead to:
  - Higher resource efficiency
  - Reduced environmental impact
  - Less societal impact



Global resource consumption (Krausmann et al., 2009)

METHODS TO QUANTIFY

- To direct efforts and investments, we need to be able to forecast material availability and quality
- Various methods exist for CDW quantification, e.g. (Wu et al. 2014):
  - Site visits;
  - Generation rate calculation;
  - Lifetime analysis;
  - Classification system accumulation;
  - Variables modelling.
- However, application of CDW forecasting methods is not common practice in resource management
- Lifetime Analysis (LA) could improve forecasting and thereby create added value in terms of environment, employment and resource management

RESEARCH QUESTION

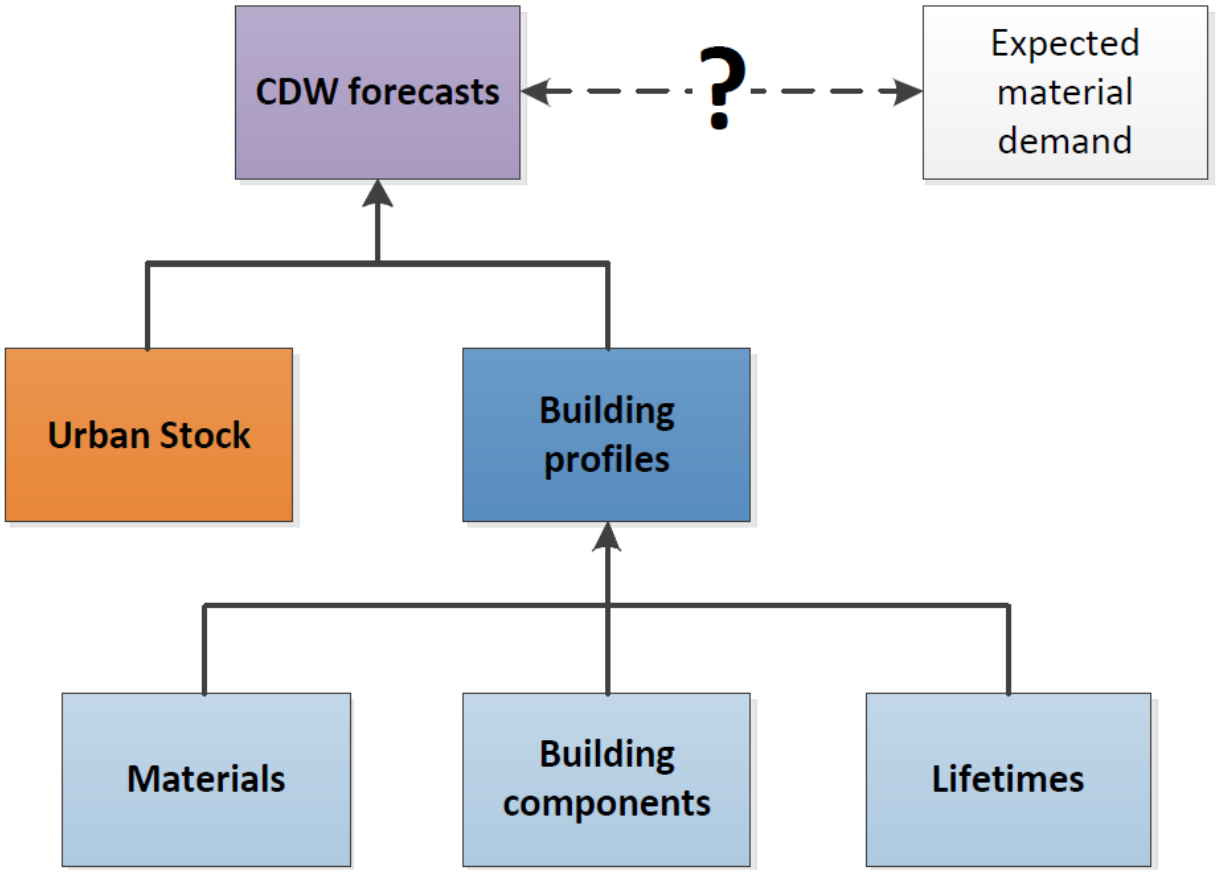
Can we develop a reliable CDW forecasting model

to be used in decision making

on resource efficiency

in the construction sector?

MODEL DESIGN



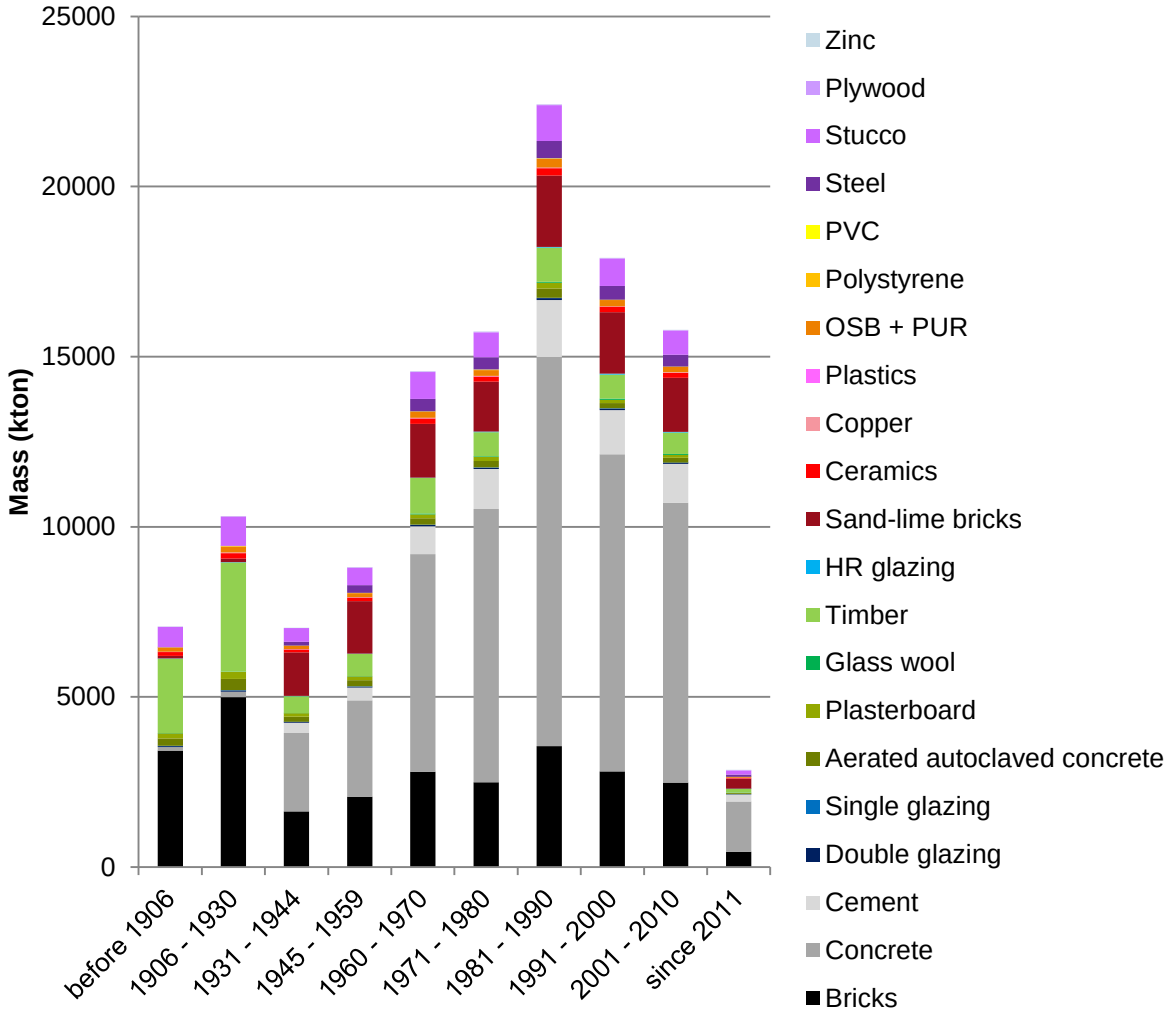
THE CASE: TERRACE HOUSES (IN AMSTERDAM)

- The Netherlands: replacement rate of dwellings is low (0.4% = dwelling lifetime of 200 years - Mulder et al. 2015)
- Amsterdam Metropolitan Area as a case study: strategically important & architecturally diverse
- Typical Dutch dwelling: terrace house
  - 8 architectural styles/construction periods
  - 15 building components
  - 23 materials
  - 10 year period (2015-2024)

Picture: Van Santvoort Makelaars

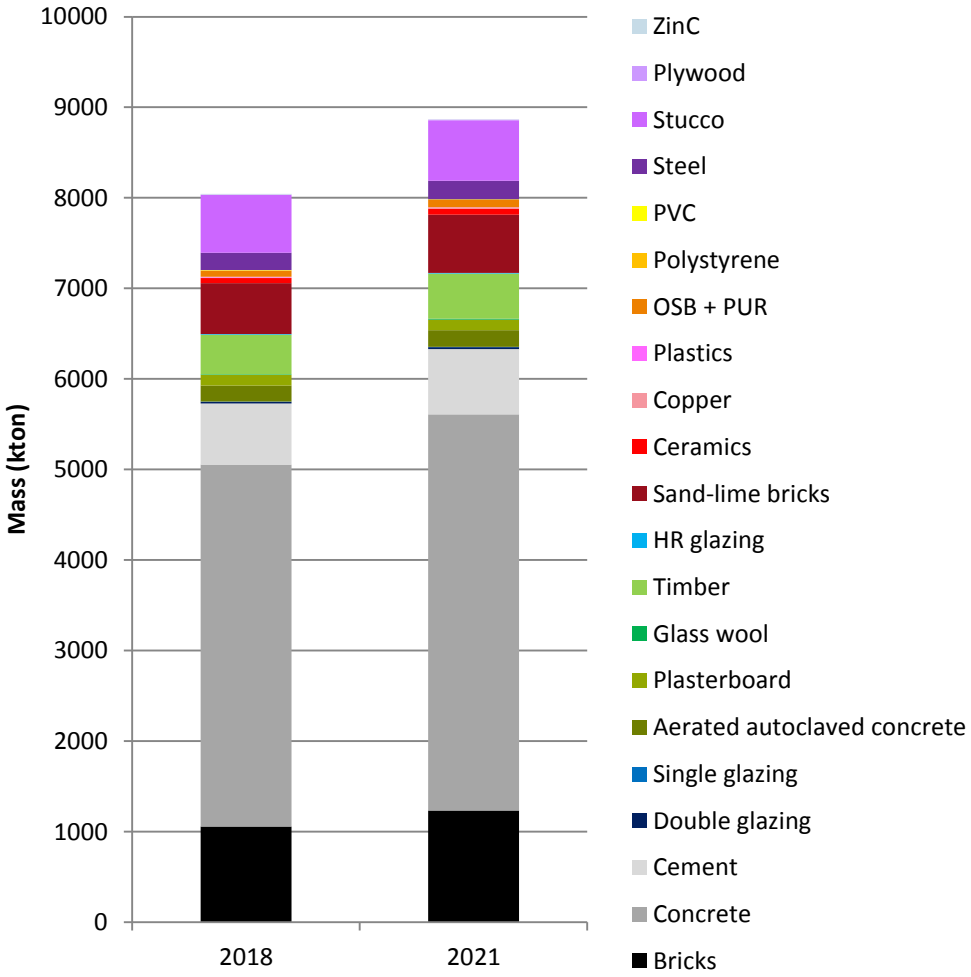
RESULTS (1): URBAN STOCK

- Urban stock of Amsterdam Area ≈ 120,000 kton of resources
- Largest volumes:
  - Concrete (41%)
  - Brick (22%)
  - Sand-lime bricks (10%)
  - Timber (9%)
  - Cement (6%)



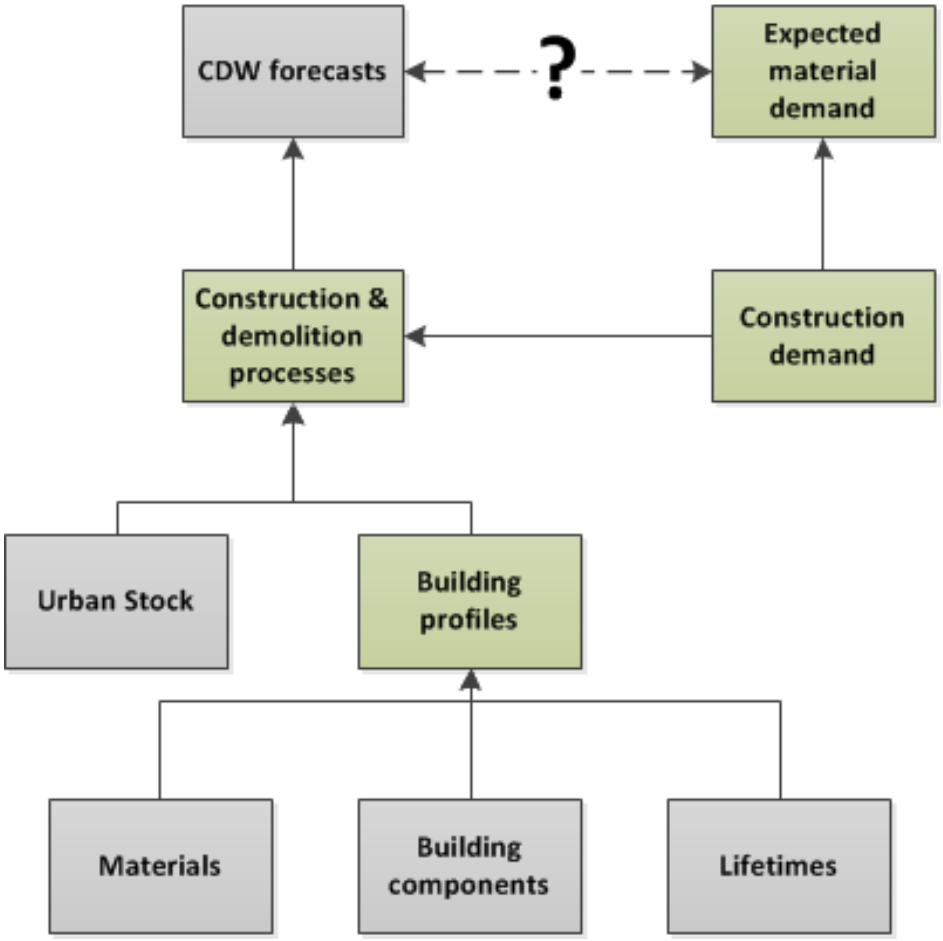
RESULTS (2): CDW FORECASTS

- CDW is estimated at 8000 to 9000 kton/year, based on average lifetime of building components
- This corresponds to roughly 7% of all materials stored in the urban stock
- Real values are influenced by more factors: e.g. less CDW due to economic circumstances



DISCUSSION OF RESULTS

- Proof of principle: model can create a starting point for transforming waste to resources
- The variation in LA forecasts is too little to be useful in year-to-year decision making
- Model is only a prototype; improvements to be made
- Validation, testing & reviews



RECOMMENDATIONS FOR FURTHER RESEARCH

- Complement the Lifetime Analysis methodology to incorporate economic circumstances
- Deepen, broaden and improve models
  - Connection to LCA & economic models
  - Improvements in data availability and accuracy
  - Case studies
- Development of a new generation of decision support tools
- New stimulus for product design


THANK YOU FOR YOUR ATTENTION
TNO innovation for life

REFERENCES

- EU Waste Framework Directive: Directive 2008/98/EC.
- Dahlbo, H., Bachér, J., Lähtinen, K., Jouttijärvi, T., Suoheimo, P., Mattila, T., Sironen, S., Myllymaa, T., & Saramäki, K. (2015). Construction and demolition waste management - a holistic evaluation of environmental performance. *Journal of Cleaner Production 107*, pp333-341.
- Wu, S. Yu, A.T.W., Shen, L., & Liu, G. (2014). Quantifying construction and demolition waste: An analytical review. *Waste Management 34 (9)*, pp1683–1692.
- Mulder, G., Koops, O., Kamphuis, V., Willems, M. Vos-Effting, S. de, Donkervoort, R., & Dijkmans, T. (2015). *Vervangende Nieuwbouw. TNO Report R10515.* TNO: Delft.
- Krausmann, F., Gingrich, S., Eisenmenger, N., Erb, K.-H., Haberl, H. and Fischer-Kowalski, M. (2009). Growth in global materials use, GDP and population during the 20th century. Ecological Economics 68(10), pp2696–2705.